Forecasting Lightning at Kennedy Space Center/Cape Canaveral Air Force Station, Florida

Winfred Lambert and Mark Wheeler
ENSCO, Inc/Applied Meteorology Unit
William Roeder
USAF 45th Weather Squadron
321-853-8130 lambert.winnie@ensco.com

The Applied Meteorology Unit (AMU) developed a set of statistical forecast equations that provide a probability of lightning occurrence on Kennedy Space Center (KSC) / Cape Canaveral Air Force Station (CCAFS) for the day during the warm season (May–September). The 45th Weather Squadron (45 WS) forecasters at CCAFS in Florida include a probability of lightning occurrence in their daily 24-hour and weekly planning forecasts, which are briefed at 1100 UTC (0700 EDT). This information is used for general scheduling of operations at CCAFS and KSC. Forecasters at the Spaceflight Meteorology Group also make thunderstorm forecasts for the KSC/CCAFS area during Shuttle flight operations. Much of the current lightning probability forecast at both groups is based on a subjective analysis of model and observational data. The objective tool currently available is the Neumann-Pfeffer Thunderstorm Index (NPTI, Neumann 1971), developed specifically for the KSC/CCAFS area over 30 years ago. However, recent studies have shown that 1-day persistence provides a better forecast than the NPTI, indicating that the NPTI needed to be upgraded or replaced. Because they require a tool that provides a reliable estimate of the daily thunderstorm probability forecast, the 45 WS forecasters requested that the AMU develop a new lightning probability forecast tool using recent data and more sophisticated techniques now possible through more computing power than that available over 30 years ago.

The equation development incorporated results from two research projects that investigated causes of lightning occurrence near KSC/CCAFS and over the Florida peninsula. One proved that logistic regression outperformed the linear regression method used in NPTI, even when the same predictors were used. The other study found relationships between large scale flow regimes and spatial lightning distributions over Florida. Lightning probabilities based on these flow regimes were used as candidate predictors in the equation development. Fifteen years (1989-2003) of warm season data were used to develop the forecast equations. The data sources included a local network of cloud-to-ground lightning sensors called the Cloud-to-Ground Lightning Surveillance System (CGLSS), 1200 UTC Florida synoptic soundings, and the 1000 UTC CCAFS sounding. Data from CGLSS were used to determine lightning occurrence for each day. The 1200 UTC soundings were used to calculate the synoptic-scale flow regimes and the 1000 UTC soundings were used to calculate local stability parameters, which were used as candidate predictors of lightning occurrence.

Five logistic regression forecast equations were created through careful selection and elimination of the candidate predictors. The resulting equations contain five to six predictors each. Results from four performance tests indicated that the equations showed an increase in skill over several standard forecasting methods, good reliability, an ability to distinguish between non-lightning and lightning days, and good accuracy measures and skill scores. Given the overall good performance the 45 WS requested that the equations be transitioned to operations and added to the current set of tools used to determine the daily lightning probability of occurrence.

A graphical user interface (GUI) was created to facilitate forecaster access to the equations through user-friendly input and fast, easy-to-read output of the lightning probability for the day. Personnel from the 45 WS were involved in the GUI development by providing comments and suggestions on the design to ensure that the final product addressed their operational needs. The probabilities output by the GUI are meant to be used as first-guess guidance when developing the lightning probability forecast for the day. They provide an objective base from which forecasters can use other observations, model data, consultation with other forecasters, and their own experience to create the final daily lightning probability for the 1100 UTC briefing.

A report describing the details of this work can be found at http://science.ksc.nasa.gov/amu/final.html.

References

Neumann, C. J., 1971: Thunderstorm forecasting at Cape Kennedy, Florida, utilizing multiple regression techniques. NOAA Technical Memorandum NWS SOS-8.